**Sculpture and Ceramics I**

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**Kite project**

**Excerpt from Wikipedia Link: http://en.wikipedia.org/wiki/Flight#Physics**

**See original for active links and more information.**

**Physics of Flight**

[](http://en.wikipedia.org/wiki/File:Luftschiff_small.jpg)

[http://bits.wikimedia.org/static-1.22wmf22/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Luftschiff_small.jpg)

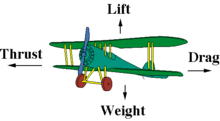
Lighter-than-air [airships](http://en.wikipedia.org/wiki/Airship) are able to fly without any major input of energy

Main article: [Aerodynamics](http://en.wikipedia.org/wiki/Aerodynamics)

There are different approaches to flight. If an object has a lower [density](http://en.wikipedia.org/wiki/Density) than air, then it is [buoyant](http://en.wikipedia.org/wiki/Buoyancy) and is able to [float in the air](http://en.wikipedia.org/wiki/Aerostat) (kite/airfoil?) without using energy. A heavier than air craft, known as an [aerodyne](http://en.wikipedia.org/wiki/Aircraft#Heavier_than_air_.E2.80.93_aerodynes), includes flighted animals and insects, [fixed-wing aircraft](http://en.wikipedia.org/wiki/Fixed-wing_aircraft) and [rotorcraft](http://en.wikipedia.org/wiki/Rotorcraft). Because the craft is heavier than air, it must generate [lift](http://en.wikipedia.org/wiki/Lift_%28force%29) to overcome its [weight](http://en.wikipedia.org/wiki/Weight). The wind resistance caused by the craft moving through the air is called [drag](http://en.wikipedia.org/wiki/Drag_%28physics%29) and is overcome by [propulsive thrust](http://en.wikipedia.org/wiki/Air_propulsion) except in the case of [gliding](http://en.wikipedia.org/wiki/Gliding_%28flight%29). Some vehicles also use thrust for flight, for example [rockets](http://en.wikipedia.org/wiki/Rocket) and [Harrier Jump Jets](http://en.wikipedia.org/wiki/Harrier_Jump_Jet).

Finally, [momentum](http://en.wikipedia.org/wiki/Momentum) dominates the flight of ballistic flying objects.

**Forces**

[](http://en.wikipedia.org/wiki/File:Forces2.gif)

[http://bits.wikimedia.org/static-1.22wmf22/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Forces2.gif)

Main forces on a heavier-than-air aircraft

Main article: [Aerodynamics](http://en.wikipedia.org/wiki/Aerodynamics)

Forces relevant to flight are[[16]](http://en.wikipedia.org/wiki/Flight" \l "cite_note-16)

* [Propulsive thrust](http://en.wikipedia.org/wiki/Air_propulsion): (except in gliders)
* [Lift](http://en.wikipedia.org/wiki/Lift_%28force%29): created by the reaction to an airflow
* [Drag](http://en.wikipedia.org/wiki/Drag_%28physics%29): created by aerodynamic [friction](http://en.wikipedia.org/wiki/Friction)
* [Weight](http://en.wikipedia.org/wiki/Weight): (created by gravity)
* [Buoyancy](http://en.wikipedia.org/wiki/Buoyancy): for lighter than air flight

These forces must be balanced for stable flight to occur.

**Lift**

Main article: [lift (force)](http://en.wikipedia.org/wiki/Lift_%28force%29)

In the context of an [air flow](http://en.wikipedia.org/wiki/Fluid_flow) relative to a flying body, the **lift** force is the [component](http://en.wikipedia.org/wiki/Vector_%28geometric%29#Vector_components) of the [aerodynamic force](http://en.wikipedia.org/wiki/Aerodynamic_force) that is [perpendicular](http://en.wikipedia.org/wiki/Perpendicular) to the flow direction.[[17]](http://en.wikipedia.org/wiki/Flight#cite_note-17) It contrasts with the [drag](http://en.wikipedia.org/wiki/Drag_%28physics%29) force, which is the [parallel](http://en.wikipedia.org/wiki/Parallel_%28geometry%29) component of the aerodynamic force. In all cases, aerodynamic lift is associated with pressures on the wing that sum over the area of the flight surfaces to create the lift force, and there is a net movement of air in the opposite direction from the force which is indirectly created by these pressures, in accordance with [Newton's third law of motion](http://en.wikipedia.org/wiki/Newton%27s_third_law_of_motion).

Lift is commonly associated with the [wing](http://en.wikipedia.org/wiki/Wing) of an [aircraft](http://en.wikipedia.org/wiki/Fixed-wing_aircraft), although lift is also generated by [rotors](http://en.wikipedia.org/wiki/Helicopter_rotor) on [rotorcraft](http://en.wikipedia.org/wiki/Rotorcraft). While common meanings of the word "[lift](http://en.wiktionary.org/wiki/lift#English)" suggest that lift opposes gravity, aerodynamic lift can be in any direction. When an aircraft is in [cruise](http://en.wikipedia.org/wiki/Cruise_%28flight%29) for example, lift does oppose gravity, but occurs at an angle when climbing, descending or banking.

Lift can also occur in a different way if the air is not still, especially if there is an updraft due to heat ("thermals") or wind blowing along sloping terrain or other meteorological conditions. This form of lift permits [soaring](http://en.wikipedia.org/wiki/Lift_%28soaring%29) and is particularly important for gliding. It is used by birds and gliders to stay in the air for long periods with little effort.

**Drag**

Main article: [Drag (physics)](http://en.wikipedia.org/wiki/Drag_%28physics%29)

For a solid object moving through a fluid, the drag is the component of the [net](http://en.wikipedia.org/wiki/Net_force) [aerodynamic](http://en.wikipedia.org/wiki/Aerodynamic_force) or [hydrodynamic](http://en.wikipedia.org/wiki/Hydrodynamics) [force](http://en.wikipedia.org/wiki/Force) acting opposite to the direction of the movement.[[18]](http://en.wikipedia.org/wiki/Flight#cite_note-18)[[19]](http://en.wikipedia.org/wiki/Flight#cite_note-19)[[20]](http://en.wikipedia.org/wiki/Flight#cite_note-NASAdrag-20)[[21]](http://en.wikipedia.org/wiki/Flight#cite_note-21) The component perpendicular to this direction is considered [lift](http://en.wikipedia.org/wiki/Lift_%28force%29). Therefore drag opposes the motion of the object, and in a powered vehicle it is overcome by [thrust](http://en.wikipedia.org/wiki/Thrust).

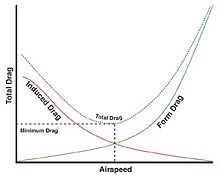
**Buoyancy**

Main article: [Buoyancy](http://en.wikipedia.org/wiki/Buoyancy)

Air pressure acting up against an object in air is greater than the pressure above pushing down. The buoyancy, in both cases, is equal to the weight of fluid displaced - [Archimedes' principle](http://en.wikipedia.org/wiki/Archimedes%27_principle) holds for air just as it does for water.

A cubic meter of air at ordinary [atmospheric pressure](http://en.wikipedia.org/wiki/Atmospheric_pressure) and room temperature has a mass of about 1.2 kilograms, so its weight is about 12 newtons. Therefore, any 1-cubic-meter object in air is buoyed up with a force of 12 newtons. If the mass of the 1-cubic-meter object is greater than 1.2 kilograms (so that its weight is greater than 12 newtons), it falls to the ground when released. If an object of this size has a mass less than 1.2 kilograms, it rises in the air. Any object that has a mass that is less than the mass of an equal volume of air will rise in air - in other words, any object less dense than air will rise.

**Lift-to-drag ratio**

[](http://en.wikipedia.org/wiki/File:Drag_Curve_2.jpg)

[http://bits.wikimedia.org/static-1.22wmf22/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Drag_Curve_2.jpg)

Speed and drag relationships for a typical flight article

Main article: [Lift-to-drag ratio](http://en.wikipedia.org/wiki/Lift-to-drag_ratio)

When lift is created by the motion of an object through the air, this deflects the air, and this is the source of lift. For sustained level flight lift must be equal to weight.

However, this lift inevitably causes some drag also, and it turns out that the efficiency of lift creation can be associated with a lift-to-drag ratio for a vehicle; the lift-to-drag ratios are approximately constant over a wide range of speeds.

Lift-to-drag ratios can be determined by flight test, by calculation or by testing in a wind tunnel.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] Lift-to-drag ratios for practical aircraft vary from about 4:1 up to 60:1 or more. The lower ratios are generally for vehicles and birds with relatively short wings, and the higher ratios are for vehicles with very long wings, such as gliders. In general, long wings permit a large amount of air to be deflected and accelerated by a small amount, rather than a small amount of air by a large amount. Since energy is a square law on deflection speed, whereas lift is a linear relation, it takes less energy, and less [lift-induced drag](http://en.wikipedia.org/wiki/Lift-induced_drag) is created, with longer wings.

**Flight dynamics**[http://bits.wikimedia.org/static-1.22wmf22/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Aileron_roll.gif)

[](http://en.wikipedia.org/wiki/File:Dihedral.airliner.arp.750pix.jpg)

[http://bits.wikimedia.org/static-1.22wmf22/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Dihedral.airliner.arp.750pix.jpg)

The upward tilt of the wings and tailplane of an aircraft, as seen on this [Boeing 737](http://en.wikipedia.org/wiki/Boeing_737), is called dihedral angle

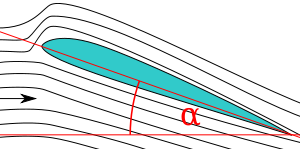
Main article: [Flight dynamics](http://en.wikipedia.org/wiki/Flight_dynamics)

**Flight dynamics** is the science of [air](http://en.wikipedia.org/wiki/Aircraft) and [space](http://en.wikipedia.org/wiki/Spacecraft) vehicle orientation and control in three dimensions. The three critical flight dynamics parameters are the angles of rotation in three [dimensions](http://en.wikipedia.org/wiki/Dimensions) about the vehicle's [center of mass](http://en.wikipedia.org/wiki/Center_of_mass), known as *pitch*, *roll* and *yaw* (See [Tait-Bryan rotations](http://en.wikipedia.org/wiki/Tait-Bryan_rotations) for an explanation).

The control of these dimensions can involve a [horizontal stabilizer](http://en.wikipedia.org/wiki/Horizontal_stabilizer) (i.e. "a tail"), [ailerons](http://en.wikipedia.org/wiki/Ailerons) and other movable aerodynamic devices which control angular stability i.e. flight attitude (which in turn affects [altitude](http://en.wikipedia.org/wiki/Altitude), [heading](http://en.wikipedia.org/wiki/Aircraft_heading)). Wings are often angled slightly upwards- they have "positive [dihedral angle](http://en.wikipedia.org/wiki/Dihedral_%28aircraft%29)" which gives inherent roll stabilization.

**From Wikipedia:** **http://en.wikipedia.org/wiki/Lift\_%28force%29#Angle\_of\_attack**

**Angle of attack (helps a kite fly)**

[](http://en.wikipedia.org/wiki/File:Angle_of_attack.svg)

[http://bits.wikimedia.org/static-1.22wmf22/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Angle_of_attack.svg)

Airflow around an [airfoil](http://en.wikipedia.org/wiki/Airfoil). The angle α is the angle of attack.

The [angle of attack](http://en.wikipedia.org/wiki/Angle_of_attack) is the angle between an airfoil and the oncoming air. A symmetrical airfoil will generate zero lift at zero angle of attack. But as the angle of attack increases, the air is deflected through a larger angle and the vertical component of the airstream velocity increases, resulting in more lift. For small angles a symmetrical airfoil will generate a lift force roughly proportional to the angle of attack.[[33]](http://en.wikipedia.org/wiki/Lift_%28force%29#cite_note-33)[[34]](http://en.wikipedia.org/wiki/Lift_%28force%29#cite_note-34)

As the angle of attack grows larger, the lift reaches a maximum at some angle; increasing the angle of attack beyond this [critical angle of attack](http://en.wikipedia.org/wiki/Angle_of_attack#Critical_angle_of_attack) causes the air to become turbulent and separate from the wing; there is less deflection downward so the airfoil generates less lift. The airfoil is said to be [stalled](http://en.wikipedia.org/wiki/Stall_%28flight%29).[[35]](http://en.wikipedia.org/wiki/Lift_%28force%29#cite_note-35)

[Cambered](http://en.wikipedia.org/wiki/Camber_%28aerodynamics%29) airfoils will generate lift at zero angle of attack. When the chordline is horizontal, the trailing edge has a downward direction and since the air follows the trailing edge it is deflected downward.[[36]](http://en.wikipedia.org/wiki/Lift_%28force%29#cite_note-36) When a cambered airfoil is upside down, the angle of attack can be adjusted so that the lift force is upwards. This explains how a plane can fly upside down.[[37]](http://en.wikipedia.org/wiki/Lift_%28force%29#cite_note-37)[[38]](http://en.wikipedia.org/wiki/Lift_%28force%29#cite_note-38)